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CURRENT BUILDING MANAGEMENT SYSTEM CAPABILITIES AND REQUIREMENTS IN SLOVAKIA – PRELIMINARY RESULTS FROM A QUESTIONNAIRE SURVEY

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Abstract. The present paper reports preliminary results of a questionnaire survey of building managers in Slovakia designed to map the current use of building management systems and identifying practical requirements for improvement of current building management platforms. Seventy-five respondents representing residential, office and public buildings completed a 20-question survey covering technical systems and monitoring, operation and maintenance, subjective assessment, and modernization preferences. Most respondents reported using some kind of building management system, but primarily for basic monitoring and control. Advanced functions such as predictive maintenance and cross-system integration were rarely used. High investment costs, insufficient technical infrastructure, and the need for staff training and better awareness were identified as key barriers to wider deployment and upgrade. Monitoring the indoor environmental quality is in many cases non-existent or limited despite only partial satisfaction with indoor conditions. The findings can serve as an input for developing a complex digital solution for building management.

Keywords: building management system (BMS), indoor environment quality, smart metering, facility management, survey.

1. Introduction

The building sector is the largest energy consumer and the second-largest emitter of CO_2 after industry. The core of the consumption is represented by the building systems that provide fresh air, thermal comfort, hot water and lighting (González-Torres et al., 2022). The potential for energy, greenhouse gas, and monetary savings in the building sector, combined with recent economic and geopolitical developments, has driven the creation of several major EU strategies, legislative frameworks, and funding schemes. Among these are the European Green Deal and its component initiative, the Renovation Wave which aims to renovate around 35 million buildings by 2030 (European Commission, 2024). In addition, the REPowerEU plan accelerates the implementation of energy efficiency and renewable energy measures (European Commission, 2025).

1.1. EPBD framework for smart buildings

The policy framework for the building sector has been further reinforced through the recast of the Energy Performance of Buildings Directive (EPBD) adopted in 2024. The revised EPBD strengthens requirements for zero-emission buildings, renovation planning, and the deployment of building automation and control systems (BACS), while placing increased emphasis on digitalisation and data availability. In this context, the Smart Readiness Indicator (SRI), established under the EPBD framework, provides a structured methodology for assessing the smart capabilities of buildings, including their ability to optimise energy performance and adapt to occupant needs. By linking building automation and monitoring systems to performance indicators, the SRI reinforces the role of intelligent control systems in achieving EU decarbonisation objectives (European Parliament & Council, 2024).

These high-level policy efforts are translated into binding requirements on building operations, facility management, and energy performance. The challenges include deployment and upgrading systems for building monitoring and automation that include predictive maintenance, occupant feedback loops, granular metering, clear billing information, data accessibility for occupants, integrating this data into facility/energy management dashboards, and more. Special considerations must be given to the integration of building management systems into building digital twins, and the application of building management systems in building renovation.

In this context, digital building twins represent an

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advanced approach to integrating monitoring, automation, and data management. A digital building twin is a dynamic virtual representation of a physical building that incorporates real-time data from sensors and building management systems to support continuous performance monitoring and optimisation. Although Directive (EU) 2024/1275 does not explicitly mention digital building twins, its emphasis on digitalisation, data interoperability, BACS, digital building logbooks, and the SRI establishes a regulatory framework that enables their implementation in both new and renovated buildings (European Parliament & Council, 2024).

1.2. State of the art in building management systems

Numerous studies confirm that building management systems (BMS) can significantly reduce building energy consumption when properly implemented. Reported energy savings typically range between 10–30% in buildings using automated monitoring and control compared to conventional rule-based operation (Van Roosmale et al., 2024; Vijayan et al., 2020). In more advanced systems that integrate IoT, AI-based analytics, and predictive control, efficiency improvements of 20 to 40% have been reported, depending on building type and control level (Leyla et al., 2025; Shahid et al., 2025).

Case studies support these findings. For example, the implementation of an integrated BMS in a hotel led to reductions of approximately 16.6% in electricity consumption, 18.2% in gas use, and 21% in CO_2 emissions within one year (Dullan-Wenceslao et al., 2025). Systems that incorporate smart sensors and IoT-based control also show measurable improvements compared to simple scheduling strategies (Aazami et al., 2025).

The literature shows that the greatest benefits occur when BMS move beyond basic monitoring to advanced control strategies, such as model predictive control (MPC), occupancy-based control, demand-controlled ventilation, and fault detection and diagnostics (FDD) (Savadkoohi et al., 2024; Sun et al., 2020; Kim et al., 2023). However, predictive and data-driven approaches are still not widely implemented in practice, with many buildings relying mainly on scheduled control (Savadkoohi et al., 2024).

Overall, research indicates that energy savings depend strongly on the level of automation, data integration, and control intelligence. Basic automation provides moderate improvements, while integrated and predictive systems deliver substantially higher energy efficiency gains. These findings support the maturity framework proposed in this study and help explain the gap between installed technologies and their effective use.

1.3. Study objective

The outlined challenges need advanced solutions able to account for them and give more information and control to the consumers and energy distributors at the same time. As a first step, feedback was collected from building managers in Slovakia to identify the current state and their preferences regarding BMS. The aim of the questionnaire survey was to explore how building managers perceive the current state of building management and energy management, what technologies they use, and what challenges they face in their daily work. The intention was to obtain a picture of the state of building management in Slovakia, the way their energy consumption is monitored, and the current level of digitalization and indoor climate.

The objective of this article is to present the main findings from the questionnaire, which will serve as feedback from building managers when developing an innovative building management system.

2. Design of the questionnaire survey

The survey has been done using a dedicated survey platform. More than three hundred persons responsible for building management were asked to participate. A total of 75 respondents participated in the survey, representing residential, office, and public buildings. Most participants work in the management of residential buildings, which are typically operated in larger numbers, while smaller property management companies are responsible for individual or specialised properties. This diversity of responses provides insights not only into the technical level and equipment of the buildings but also into the approaches taken by building managers.

The questionnaire consisted of twenty questions, many of which were answered by all participants, enhancing the reliability of the results, and was organised into five categories to ensure comprehensive data collection (Figure 1). It should be noted that these findings reflect the Slovak context. While there are likely similarities with other Central European countries, the sample size and its distribution are insufficient to extrapolate the results directly to other countries.

Figure 1. Question categories in the questionnaire survey

3. Results and discussion

From the total of 75 participants, a small part skipped a few of the initial questions about the respondent, for example the type of buildings under management and the number of buildings. These were likely experts on energy management who, however, did not managed buildings themselves. The results are presented and discussed in the five categories following the structure of the questionnaire.

3.1. Information about respondents

Figure 2 shows the distribution of the building types managed by the respondents. In the graph, the first numerical value indicates the number of buildings and the second one reports the percentage from the whole. We collected 117 responses to the first question due to the possibility of multiple selections, although the survey involved 75 respondents in total, suggesting that some facility managers oversee various types of properties. The largest share of respondents manages residential buildings, followed by office buildings, while public buildings are less common.

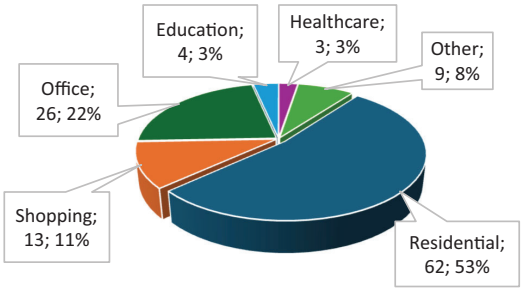

Figure 2. Distribution of building type managed by respondents

The largest group of participants manages 21 to 80 buildings (39%). A substantial share is also made up of smaller-scale managers who oversee up to 20 properties (32%). A relatively high proportion (12%) manage more than 200 buildings. The majority of respondents (62%) operate in the private sector, where they primarily manage commercial and residential buildings This group typically includes managers responsible for commercial and residential buildings, which also corresponds to the most frequently selected building types. The public sector is represented by 24% of respondents. These include e.g. managers of schools or hospitals.

3.2. Technical systems and monitoring

In this question, the respondents could choose from four options: (1) Manual readings, (2) Smart meters, (3) Integrated system (BMS – Building Management System), and (4) Other. Using their expertise, the participants selected the option closest to their reality.

Figure 3 shows that most facility managers use smart meters, for the automatic recording of energy consumption data, which can be considered an initial step towards digitalization. A smaller proportion of managers have already implemented building management systems (BMS). This indicates a relatively high level of digitalization and modernization in facility management practice while a considerable percentage still use manual reading.

Despite two thirds of respondents reporting the use of smart meters or integrated BMS, the results indicate that data are most often made available annually (38%) or monthly (30%), mainly in relation to invoicing. Only about one sixth of participants reported having access to real-time data. This discrepancy likely reflects that respondents perceived "data availability frequency" more as the billing interval rather than the actual accessibility of measured values from the system.

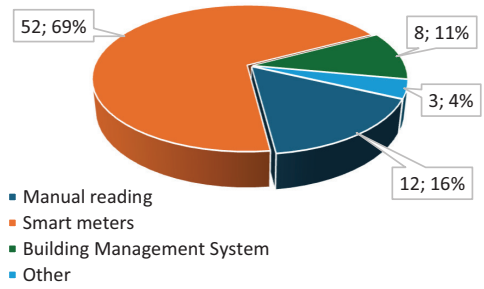

Figure 3. Type of monitoring system

The most common category where BMS is used is residential buildings. This is consistent with the fact that residential buildings were the most frequently managed type overall. Office buildings are the second most common category, which is expected given the higher technical requirements and more frequent use of central management in these buildings. The most frequently used feature is monitoring, and the second most common feature is control and management. The least used features include predictive maintenance and integration with other systems, indicating room for further development and more advanced use of BMS (Figure 4).

Figure 4. BMS features, from most to least frequently used

The most frequently perceived benefit is better control over building operations and energy savings. Better maintenance planning (9%) and reduced service interventions (7%) are perceived to a lesser extent, suggesting that these benefits may depend on more advanced BMS usage. A total of 51 respondents answered the question about barriers to wider implementation or use of BMS. As multiple options could be selected, we recorded 141 responses in total. The most frequently mentioned barrier is high initial investment costs (26%). The second major barrier is insufficient technical infrastructure (19%), indicating that some buildings may not be adequately prepared for BMS installation or expansion. As the most important barrier to BMS implementation and upgrade were identified the need for staff training and insufficient awareness of BMS benefits.

About 90% of the managers do not monitor indoor environmental quality and do not have any monitoring system installed in their buildings. Those who do indicate the indoor temperature as the most commonly monitored parameter.

3.3. Operation and maintenance

About 70% of managers stated that they perform inspections regularly according to an established maintenance plan (Figure 5), however, they are carried out mainly manually. By contrast, 28% of respondents do not have a planned inspection schedule and address maintenance only as needed. Regarding energy savings, as many as 76% of managers stated that they do have a person responsible for energy efficiency, out of which 57% internally and 19% in the form of an external consultant.

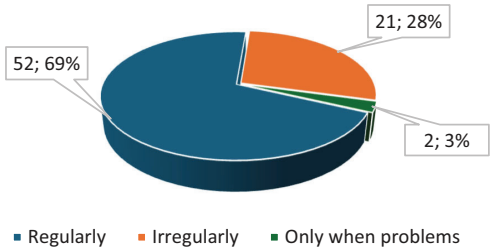

Figure 5. Regularity of building inspections

More than 80% stated that they actively or at least partially use monitored data. The remainder do not use the data at all, representing unused potential of available measurement and monitoring technologies. Survey results also show that most managers have a good overview of the development of energy consumption and related costs over the last two years. Only two managers admitted that they do not monitor energy consumption at all, which represents a negligible share of the total sample. As many as 71% stated that they know the critical areas in terms of energy demand, while 18% have only partial insight. The remaining 11% admitted that they cannot precisely identify the main sources of energy consumption. Insufficient knowledge in this area may result from limited monitoring.

3.4. Subjective assessment

Regarding the perceived quality of the indoor environment, the largest share stated that they are only partially satisfied and about 10% were outright dissatisfied (Figure 6). This indicates the room to improve indoor comfort conditions. The dissatisfaction concerns multiple aspects; most respondents (35%) identified humidity as a problem.

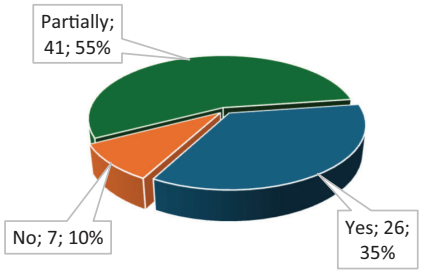

Figure 6. Satisfaction with the indoor environment quality

The managers had greatest interest in automatic control of systems with operational optimization and monitoring of the indoor environment, which they perceive as an important tool for improving comfort and managing energy consumption effectively. From the answers, growing interest in monitoring the indoor environment was evident.

Asking what payback period of the investment would be acceptable, the largest group of managers (40%) considers a period of up to six years acceptable, which corresponds to typical investment cycles in facility management (Figure 7). About a quarter would prefer a faster payback within 3 years, while 10% would accept up to 10 years. About a quarter would not consider modernizing the system because they are satisfied with the current condition.

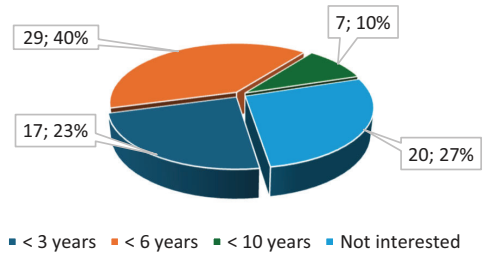

Figure 7. Acceptable payback period of investment to building management system

3.5. Preferences

In this part of the questionnaire, respondents answered about the current state of their system, how it functions and is maintained, and what elements or technologies they would welcome in its modernization. The aim of this part of the survey was to obtain an overview of the level of digitalization, automation, and technical maturity of energy-management systems in managed buildings, as well as managers' attitudes toward further development and modernization of these systems. Each respondent could choose from four options expressing the level of implementation and use of the given element in practice:

- they have it and use it,
- they have it but don't need it,
- they don't have it and they miss it,
- they don't have it and don't miss it.

This response structure made it possible to assess not only the technical equipment of managers, but also their perception of the importance of individual elements, that is, whether these are actively used tools, unused potential, or areas that managers do not consider a priority.

Figure 8 shows that the most frequently selected option was "they have it and use it", indicating that most managers actively work with available systems and information. The second most common option was "they don't have it and they miss it", indicating interest in expanding and modernizing existing systems. In some

cases, however, the answer "they don't have it and don't miss it" prevailed, suggesting that managers do not consider certain technologies or processes a priority or necessary for their current work. Only a small number of respondents selected "they have it but don't need it", confirming that managers perceive most system functions as beneficial. Overall, the results suggest that managers are open to innovation and improving their energy-management systems, while only a smaller part remains passive toward new technologies.

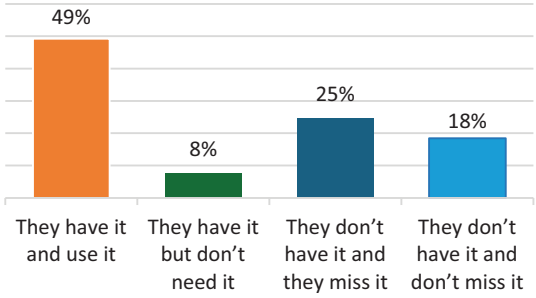

Figure 8. Energy management maturity level

In the final question, respondents could express in their own words what is missing in their BMS or which tools they have but do not use in practice. A total of 32 managers responded to this question. Their answers were diverse and could be grouped into eight thematic categories. The largest group (28%) stated that they lack smart monitoring of energy consumption, confirming an ongoing need for digitalization and automation in this area, 22% are satisfied with the current building management system and do not feel the need for major changes, and another 16% pointed out problematic data clarity, system complexity, and a lack of notifications.

3.6. Conceptual framework for BMS maturity levels

The anonymity of the survey and the structure of the questionnaire did not allow individual responses to be linked to specific building types. Therefore, the level of BMS maturity could not be quantitatively determined for individual building categories. The BMS maturity levels were therefore based on qualitative interviews with five representative building managers. These interviews informed the development of a conceptual framework comprising four BMS maturity levels, ranging from basic monitoring to predictive control driven by artificial intelligence (Figure 9).

These insights suggest that public and residential buildings are predominantly at lower maturity levels, primarily focused on monitoring and rule-based control processes (Levels 1–2). More advanced analytical and predictive functions (Levels 3–4) were identified mainly in selected office buildings or within pilot projects.

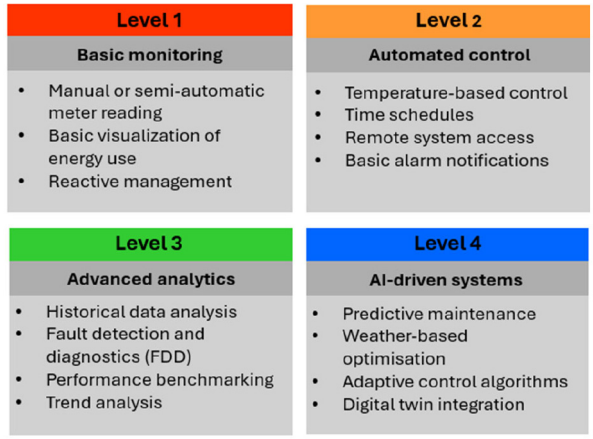

Figure 9. Conceptual framework for BMS maturity levels

4. Conclusions

The survey indicates that building managers in Slovakia are already exposed to digital building operation through smart metering and BMS. However, the practice is still focused on basic monitoring and control, with data mostly used for consumption tracking or billing purposes instead of advanced capabilities. Respondents associate BMS mainly with improved operational oversight and savings rather than predictive maintenance and diagnostics. This suggests a gap between the technological capabilities of installed systems and real use.

The survey also highlighted the limited awareness of the benefits of modern technologies and the need for staff training. These were seen as one of the main reasons why these systems are not more widely used. Improving professional skills and offering training could help organizations make better use of existing technologies and more easily introduce new management solutions.

A notable finding is the low penetration of indoor environmental quality monitoring, even though many respondents are only partially satisfied with indoor conditions. This indicates an opportunity to connect energy management with comfort management through sensing, clear visualization, and feedback loops. Respondents' preferences and acceptable payback expectations of mostly up to six years provide practical boundary conditions for installation of the management system.

Overall, respondents show demand for an integrated platform that integrates measurement, monitoring and maintenance into a single user-friendly environment. The insights should help develop an innovative building management platform that is easier to operate, aligned with renovation needs, and supporting complex facility management.

The identified expectations and barriers are consistent with current trends in next-generation BMS, such as advanced data analytics, fault detection and diagnostics (FDD), predictive control, cloud-based platforms, and digital building twins. For future upgrades,

modernization should focus on integrating existing systems, automating routine processes, and making data easier to understand. The digital foundation would enable effective use of AI tools and long-term improvements in building performance.

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